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The Economics of Corn Ethanol

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Someone e-mailed a few days ago and asked about the present economics of corn ethanol. I did a few calculations, and thought the results were interesting enough to share. This exercise should make it clear which factors have the biggest impact on corn ethanol profitability – and why corn ethanol producers are presently struggling.

Consider this a supplement to Stuart Staniford's comprehensive essay Fermenting the Food Supply. Stuart's essay goes into great detail on the factors underlying the economics. In my essay, I take a snapshot of a corn ethanol plant based on current prices for corn, natural gas, and by-products. (*Note that because this is a snapshot, the numbers will change over time. But you should be able to use the methodology here to roughly calculate the economics at any point in time.*)

I found multiple references for all of the numbers I am going to use, but I will only reference a single source. According to Ethanol Reshapes the Corn Market, one 56-pound bushel of corn will yield up to 2.7 gallons of ethanol and 17.4 pounds of distiller's dried grains with solubles (DDGS).

The current spot price of corn as of this writing is about $5/bushel, so each gallon of ethanol contains $5/2.7, or $1.85 of corn per gallon of ethanol (or if you prefer, 21 pounds of corn per gallon of ethanol). However, the DDGS can be sold, so a credit is applied for that. The current price of DDGS as of this writing is $170/ton, which is $0.085/lb. Given that a bushel of corn yields 17.4 pounds of DDGS, there is then a $1.48 credit, which spread over 2.7 gallons is equal to $0.55 gallon. This reduces our cost per gallon to $1.85 minus $0.55, or $1.30 for just the corn input. This also reduces our net corn input down to 14 pounds per gallon of ethanol produced. (Note that there is sometimes a credit for carbon dioxide sales, but it is very small relative to the other costs and credits).

I still have to consider utilities (natural gas is a major cost), labor, enzyme and yeast costs, and depreciation. I have a spreadsheet from an actual ethanol plant, but there isn't much in the public domain that I could find on this. The closest thing to a source on these is the spreadsheet in the presentation Fossil Fuels and Ethanol Plant Economics (for a standard dry mill process). If you look at Page 16 of the presentation, you can see that all of the miscellaneous costs together total approximately as much as the corn inputs. If you take the spreadsheet on Page 24 and change the natural gas price to the current price of $8/MMBTU, you get an overall energy cost of $0.33/gal of ethanol [*Note: Some have pointed out that the energy usage in that spreadsheet looks pretty low, and that the average energy usage for a plant is probably higher than that*]. The sum of enzymes, yeast, and other chemicals comes out to be $0.14/gal, and labor, maintenance, and various miscellaneous expenses add another $0.23/gal.

On depreciation, I have several sources for capital costs that are pretty consistent. In the EIA's

Energy Outlook 2006, capital costs per daily barrel of corn ethanol ranged from $20,000 to $30,000, depending on the size of the plant. This breaks down to between $1.30 and $1.95 per gallon of installed capacity. This is also consistent with A Guide for Evaluating the Requirements of Ethanol Plants, which states "*Current capital cost per annual gallon of installed capacity for an ethanol plant ranges from $1.25 to $2.00*." So let's be conservative and say that we want to build a big plant, so the capital costs are on the low end at $1.30/gallon. Depreciate that over 15 years and this portion amounts to about $0.08 per gallon (but is captured above already).

However, for biomass to liquids facilities - which would include the biomass gasification to ethanol that some are calling cellulosic ethanol - the capital costs in the EIA's Energy Outlook 2006 are listed at around 5 times that of a conventional corn ethanol plant. Thus, the capital depreciation portion is going to be around $0.40 per gallon of ethanol. (On the other hand, the feed costs should be much lower).

Summary

Times are tough for ethanol producers. They are in the same boat right now as refiners - enduring very poor margins. This is what the economics roughly look like at $5 per bushel of corn and $8/MMBTU of natural gas. To produce 1 gallon of ethanol today requires:

- $1.85 of corn
- $0.33 of energy
- $0.14 of enzymes, yeast, etc.
- $0.23 of labor, maintenance, and various miscellaneous expenses

There is a DDGS credit per gallon of ethanol of $0.55. Thus, the total cost to produce a gallon of ethanol today is $1.85 + $0.33 + $0.14 + $0.23 - $0.55, or exactly $2/gallon of ethanol. For reference, the February contract for ethanol in the Midwest as of this writing is $2.15. And $2/gallon is merely cost of production. It doesn't take into account any return on investment.

Also note that due to the lower energy content, this production cost is equivalent to a $3 per gallon production cost for gasoline - and that this production cost is a moving target: As long as the ethanol mandates are driving up the price of corn and increasing the demand for and cost of natural gas, corn ethanol producers must chase their tails in a vicious cycle. Producers are going to be hard-pressed to ever match the 2006 windfall that was given to them when the MTBE phaseout drove ethanol prices sky-high.

Anyway, this was a useful exercise for me to understand the magnitude of the various inputs (and the DDGS offset) in corn ethanol production. I hope you found it of some value. If you see errors or have suggestions, please let me know.